

## CLIMATE—SHADOWS AND WIND

### AFFECTED ENVIRONMENT

#### Shadows and Sun

The relative amount of shadow and sun available at the pedestrian level depends upon the landform, climate, vegetation, surrounding buildings, signs and bridges. In general, the land slopes downward to the southwest or west throughout much of Downtown, maximizing the potential sunlight during the midday and afternoon hours. Shadows cast by buildings create a mixed pattern of sunny and shady areas at street level, changing throughout the day and varying with the season. In the winter, portions of the retail and office cores are in the natural shadows of hills to the east until mid-morning. Although long periods of sunny weather are not uncommon, a clear day or two frequently provides a pleasant break after several continuous weeks of overcast skies, which can occur during any season.

The changing orientation of the street grid divides Downtown into three sectors. During daylight savings time, the heavily pedestrian-traveled avenues in the intensely developed central sector are exposed to full sunlight for a brief period around noon, while the east/west-oriented streets receive full sunlight later in the afternoon. These same changes occur roughly an hour earlier in the northern sector, and later in the southern sector. At other times of the day, both streets and avenues are affected, to varying degrees, by shadows from buildings. Building heights and widths are the primary factors affecting the amount of shadow, but other characteristics such as street level or upper level setbacks, locations of towers within a block, gaps between buildings, recessed plazas, roof overhangs, and marquees can modify the total amount and pattern of sun and shadow on the streetscape.

Although pedestrians tend to move to the shady side of the street on hot days, the more frequent choice is to walk in available sunlight along a route. Even on the hottest days, the sunniest parks and open spaces attract the most people. In a climate that is frequently gray and cloudy, sunshine provides a psychological lift, and the availability of sunlight at the street level Downtown is considered a valuable resource.

**Relationship to building height and bulk.** Very generally, higher building heights extend the *length* of the shadow cast, and increased bulk (or cross-section width) *widens* the shadow cast by a building. While the longer shadows may mean they are noticed farther from a building, their effects on more distant locations are briefer, because the sun's motion translates into faster movement of the shadow over the ground. Buildings with increasing amounts of bulk will generally result in wider shadows and an increased amount of shadowed area. The amount and impact of shadows cast by a group of buildings depends upon the spacing, orientation and relative locations of those buildings (e.g., some building arrangements may result in overlapping shadows, or cast shadows in patterns that are not detrimental to public areas where solar access is desirable). Effectively planning the spacing, orientation and relative locations of new buildings within a group of buildings can sometimes result in benefits, such as lesser area in shadow, or retention of good solar access in favored areas. Conceptually, taller and narrower towers with wide spacing may result in shadow impacts and light conditions that are more transitory and less objectionable than conditions resulting from lower and more bulky buildings set close together.

#### Wind

The onshore winds over coastal areas give Seattle a milder and moister climate than if winds were from the interior of the continent. The prevailing winds in Downtown Seattle blow from the south and southwest (about 22 percent of the time). In the summer months, prevailing winds are also experienced from the northwest (about 20 percent of the time).

Ground-level wind speeds can be significantly higher than speeds of prevailing winds. For example, a study conducted at 1001 Fourth Avenue Plaza (formerly the SeaFirst Tower) in 1978 recorded winds at the base of the building that were twice the velocity of prevailing winds. The increase in wind velocity near the ground can be caused by groupings of buildings that create corridors channeling winds, as well as by the shape, size, and position of the buildings.

In general, taller buildings with large, flat sides perpendicular to prevailing winds cause “downwash” currents that travel down the face of the structure. Downwash velocity may be greater than prevailing wind speeds. Round buildings or buildings at a 45-degree angle to the wind direction tend to reduce downwash. The Westin Hotel is an example of a design that helps to mitigate this downwash effect.

The orientation of the street grid relative to the prevailing winds influences street-level wind conditions when building walls parallel the grid. The grid orientation varies throughout Downtown, producing different wind conditions on the same day. The northern portion of Downtown between Denny Way and Stewart Street is oriented at a 49-degree angle west of north, with the long side of the blocks running from northwest to southeast. Prevailing summer winds from the northwest parallel these streets, while winter winds from the south form an acute angle with the long side of the block. This sector is least likely to experience the downwash effect during the summer months.

The vicinity between Stewart Street and Yesler Way is oriented with the long side of the blocks running from the north-northwest (32 degrees) to south-southeast. Both prevailing summer and winter winds form acute angles with the long block face. This sector is more likely than the north sector to experience the downwash effect throughout the year. South of Yesler Way to Royal Brougham Way, the street grid is oriented north/south. Winter winds blow parallel to the north/south streets. Prevailing summer winds form an acute angle with the street grid. Downwash effects would be similar to the north sector except the impacts would occur during the summer months.

Wind at the pedestrian level is accompanied by turbulence such as varying velocities, gusts and eddies. Researchers have established a relationship between ground-level wind effects on people and wind speed standards for pedestrian comfort. Each site and building project may have different effects on human comfort. Other nearby building developments may also influence particular wind effects at a given site. For some building types, the patterns of at-grade winds are predictable, by investigating relationships between climate, the site, the building form, and the resulting comfort and safety. As a result, it is possible to avoid creation of severe wind velocities from new development in urban areas.

At the pedestrian level, the building form, planting, and contours of the site often affect winds. Three general types of wind patterns affect wind flows at pedestrian levels: downwash wind flows from exterior walls to the base of a building; abrupt changes in wind speeds caused by differences in pressure between exposed and sheltered areas; and winds concentrated through openings such as passageways or arcades.

**Relationship to building height and bulk.** Tall buildings and structures can notably affect the wind environment for pedestrians. In cities, groups of structures tend to slow the winds near ground level, due to the friction and drag of the structures themselves. However, buildings that are much taller than the surrounding buildings intercept and redirect winds that might otherwise flow overhead, and bring them down the vertical faces of the building to ground level, where they can create ground-level wind and turbulence. These redirected winds can be relatively strong and also relatively turbulent, which can be incompatible with the intended uses of nearby ground-level spaces, or even hazardous.

Generally, the taller the high-rise building, the stronger the winds it encounters. These stronger winds are redirected down the face of the building. These redirected winds can be especially strong when the upwind buildings are much shorter, and can be diminished when the upwind buildings’ heights are similar to the height of the subject building. If, in addition, the building provides a wide face to the wind, more

wind will be directed down that face of the building toward ground level. Thus, both height and bulk can increase wind effects. However, these wind effects on the ground level usually can be controlled by design features that redirect those winds away from pedestrian areas. Typically, it is sufficient to provide a horizontal deflecting structure near the base of a building so that winds coming down the building face are redirected horizontally above the ground level. This is an effective design strategy for both taller towers and lower, bulkier buildings.

## **IMPACTS**

### **Alternative 1 – High End Height and Density Increase**

Consideration of shadow impacts under the City’s SEPA Ordinance is limited to certain open space resources in Downtown, as well as certain other locations such as schoolyards. Some regulatory guidance on control of wind effects is provided by City codes and design review processes. The following is intended as a qualitative discussion of adverse effects on the comfort of the urban setting, and is not meant to extend SEPA or regulatory protection to these topics beyond that currently afforded by City codes and ordinances.

The potential shadow and wind effects due to future development under Alternative 1 are summarized in Table 38 below.

**Table 38**  
**Shadow and Wind Effects of Alternative 1**

<b>Potential Shadow Effects</b>	<b>Potential Wind Effects</b>
<ul style="list-style-type: none"> <li>• Future developments in the DOC 1 office core may add to total extent of shading of city streets, although existing buildings already result in considerable shading.</li> <li>• Taller buildings in all of Denny Triangle would add to shading of city streets.</li> <li>• Taller buildings in 1<sup>st</sup>/Western Ave. vicinity and edge of Belltown would add to shading of city streets.</li> <li>• Additional shading of Downtown SEPA-identified parks not likely to occur due to zoning changes.</li> <li>• Additional building heights near Denny Park at Denny Way create slightly greater potential for shading impacts on the park.</li> </ul>	<ul style="list-style-type: none"> <li>• Future new buildings in the office core and some peripheral areas would create the potential for additional wind effects near street level. However, interspersing of new buildings with existing buildings may help protect them from some wind exposure.</li> <li>• The additional bulk and distribution of future development in the Denny Triangle may provide some additional buffering of winds from the north. However, the new buildings at the northern periphery would be exposed to those winds and their effects.</li> <li>• Site design and architectural features can help avoid or reduce potential adverse wind effects at street level.</li> </ul>

### **Alternative 2 – Concentrated Office Core**

The potential shadow and wind effects due to future development under Alternative 2 are summarized in Table 39 below.

**Table 39**  
**Shadow and Wind Effects of Alternative 2**

Potential Shadow Effects	Potential Wind Effects
<ul style="list-style-type: none"> <li>• Potential shadow effects in DOC 1 office core would be nearly the same as for Alternative 1.</li> <li>• No zone changes in peripheral areas of Denny Triangle would result in somewhat less potential for shading of city streets.</li> <li>• No zone changes in 1<sup>st</sup> Ave./ Western Ave. vicinity or edge of Belltown would avoid additional shading effects.</li> <li>• Similar to Alternative 1, additional shading of Downtown SEPA-identified parks is not likely.</li> <li>• No zone changes near Denny Way would avoid additional shading effects on Denny Park.</li> </ul>	<ul style="list-style-type: none"> <li>• Potential wind effects in the office core would be nearly the same as for Alternative 1.</li> <li>• Due to somewhat less height and bulk of future buildings in the Denny Triangle and peripheral areas, potential wind effects would be somewhat less than for Alternative 1.</li> <li>• As with Alternative 1, site design and architectural features can be used to avoid or reduce potential adverse wind effects at street level.</li> </ul>

### Alternative 3 – Residential Emphasis

The potential shadow and wind effects due to future development under Alternative 3 are summarized in Table 40 below.

**Table 40**  
**Shadow and Wind Effects of Alternative 3**

Potential Shadow Effects	Potential Wind Effects
<ul style="list-style-type: none"> <li>• Potential shadow effects in DOC 1 office core would be nearly the same as for Alternative 1.</li> <li>• Less intensive zoning in peripheral areas of Denny Triangle, edge of Belltown and 1<sup>st</sup> Ave./Western Ave. vicinities would result in less potential for shading of city streets than Alternatives 1 or 2.</li> <li>• Similar to Alternative 1, additional shading of Downtown SEPA-identified parks is not likely.</li> <li>• Changes would not affect zoned height/density near Denny Way, thus avoiding additional shading effects on Denny Park.</li> </ul>	<ul style="list-style-type: none"> <li>• Potential wind effects in the office core would be slightly less than for Alternatives 1 or 2.</li> <li>• Due to somewhat less height and bulk of future buildings in the Denny Triangle and peripheral areas, potential wind effects would be somewhat less than for Alternatives 1 or 2.</li> <li>• As with the other alternatives, site design and architectural features can aid in avoiding wind effects at street level.</li> </ul>

### Alternative 4 – No Action

#### SHADOWS, SUN AND WIND

The potential shadow and wind effects due to future development under Alternative 4 are summarized in Table 41 below.

**Table 41  
Shadow and Wind Effects of Alternative 4**

Potential Shadow Effects	Potential Wind Effects
<ul style="list-style-type: none"> <li>• No zone changes, but future developments under existing height/density limits could add to total extent of shading of city streets.</li> <li>• No zone changes, but future developments under existing height/density limits could add to shading of city streets in Denny Triangle and other peripheral areas of Downtown. However, existing bulk and site coverage regulations provide some benefits in avoiding shading from upper level bulk.</li> <li>• No impact on Downtown SEPA-identified parks, but future development closer to protected parks could possibly trigger the need to use SEPA protections.</li> </ul>	<ul style="list-style-type: none"> <li>• No impacts. However, due to less potential for height and bulk in future development, potential wind effects in the office core would be slightly less than for Alternatives 1, 2 or 3.</li> <li>• No impacts. However, due to somewhat less height and bulk of future buildings in the Denny Triangle and peripheral areas, potential wind effects would be slightly less than for Alternatives 1, 2 or 3.</li> <li>• Existing bulk and site coverage regulations provide some benefits in avoiding wind effects.</li> <li>• As with the other alternatives, site design and architectural features can aid in avoiding wind effects at street level.</li> </ul>

## **MITIGATION STRATEGIES**

### **Possible Mitigation Strategies**

Given the current regulations, including the City's SEPA Ordinance, none of the alternatives are expected to generate significant adverse shadowing or wind impacts. Therefore, no SEPA mitigation measures are required to be implemented. However, the City may wish to explore a few strategies over the long term to improve overall consideration of shadowing and wind effects of future development.

- The City could review existing regulations and guidelines pertaining to control of wind effects. Additional quantitative criteria on acceptable wind speeds and/or design criteria for avoiding adverse wind conditions at the street level of structures could be provided. If identified, inconsistencies in Code requirements and guidelines could be remedied. This could aid City reviewers in evaluating the performance of proposals with regard to wind abatement.
- The City could consider additional design guidelines or regulatory requirements to assure that important public open spaces continue to have solar access. This could mean considering additional locations for SEPA protection against possible shadow impacts, and/or other measures.

### **SIGNIFICANT UNAVOIDABLE ADVERSE IMPACTS**

None are identified.